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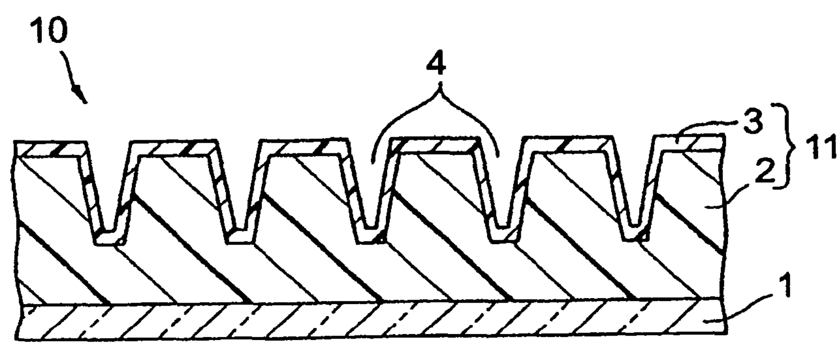
(54) Title: FLEXIBLE MOLD AND METHOD OF MANUFACTURING MICROSTRUCTURE USING SAME



(57) Abstract: To provide a flexible mold capable of easily and correctly manufacturing protuberances such as PDP ribs at predetermined positions with high dimensional accuracy. A flexible mold comprises a support made of a material having a tensile strength of at least 5 kg/mm2 and containing a moisture to saturation at a temperature and a relative humidity at the time of use by moisture absorption treatment applied in advance, and a molding layer having a groove pattern having a predetermined shape and a predetermined size on its surface.

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FLEXIBLE MOLD AND METHOD OF MANUFACTURING MICROSTRUCTURE USING SAME

FIELD OF THE INVENTION

This invention relates to a molding technology. More particularly, this invention relates to a flexible mold and to a manufacturing method of a microstructure using the flexible mold.

BACKGROUND

Display devices that use a cathode ray tube (CRT) have economically been mass-produced owing to the progress and development of television technologies achieved up to this date, as is well known in the art. In recent years, however, a thin and lightweight flat panel display has drawn increasing attention as a display device that may replace CRT display devices.

A typical example of such flat panel displays is a liquid crystal display (LCD). LCDs have already been used as compact display devices in notebook type personal computers, cellular telephone sets, personal digital assistants (PDA), and other mobile electronic information devices. Plasma display panels (PDPs) are another example of thin, large-scale flat panel displays. PDPs have been used as wall-hung television receivers for business or home.

For example, Fig. 1 illustrates one example of a PDP 50. In the example shown in the drawing, only one discharge display cell 56 is shown in the PDP for simplification, but the PDP includes a large number of small discharge display cells. In detail, each discharge display cell 56 is encompassed and defined with a pair of glass substrates opposing each other in a spaced-apart relation, that is, a front glass substrate 61 and a back glass substrate 51, and a rib 54 of a microstructure having a predetermined shape and interposed in a predetermined shape between these glass substrates. The front glass substrate 61 has transparent display electrodes 63 each constituted by a scanning electrode and a holding electrode, and a transparent dielectric layer 62 and a transparent protective layer 64 that are arranged on the substrate 61. The back glass substrate 51 includes address electrodes 53 and a dielectric layer 52 formed thereon. The display

electrodes 63 consisting of the scanning electrode and the holding electrode, and the address electrodes 53 cross one another and are respectively arranged in a predetermined pattern with gaps among them. Each discharge display cell 56 has a phosphor layer 55 on its inner wall, and a rare gas (for example, Ne-Xe gas) is filled into each discharge display cell so that self-light emission can be effected by plasma discharge between the electrodes.

A rib (e.g., rib 54 of Fig. 1), which is generally formed of a ceramic microstructure, is located on the back glass substrate and constitutes a part of the PDP back plate. As described, in particular, in International Patent Publication No. 00/39829 and Japanese Unexamined Patent Publication (Kokai) Nos. 2001-191345 and 8-273538, a curable ceramic paste and a flexible resin mold can be used to manufacture such a PDP back plate. This flexible mold has a molding layer having groove portions of a predetermined pattern on a support, and the curable ceramic paste can be easily filled into the groove portions due to its flexibility without entrapping air bubbles. When this flexible mold is used, the mold release operation after curing of the paste can be conducted without damaging the ceramic microstructure (e.g., the rib) and the glass substrates.

To manufacture the PDP back plate, it has been further required to arrange the ribs at predetermined positions with hardly any error from the address electrodes. For, if each rib is more correctly disposed at the predetermined position and its dimensional accuracy is higher, better self-light emission becomes possible.

When the flexible mold described above is used to manufacture the PDP back plate, it is desirable to arrange easily, correctly and with high dimensional accuracy, the ribs at the predetermined positions without calling for a high level of skill. For, when the flexible mold is used to form the ribs, the ribs can be formed without entrapping the bubbles and without damaging the ribs as described herein.

SUMMARY OF THE INVENTION

The present invention provides a flexible mold that includes a support and a molding layer. The flexible mold may be used to manufacture PDP ribs or other microstructures. Further, the flexible mold may be used to precisely arrange a protuberance such as a rib at a predetermined position with high dimensional accuracy and without defects such as bubbles or pattern deformation.

What is claimed is:

1. A flexible mold comprising:

a support made of a material having a tensile strength of at least 5 kg/mm^2 and containing moisture to saturation at a temperature and a relative humidity at the time of use by a moisture absorption treatment applied in advance; and

a molding layer disposed on said support, a surface thereof being provided with a groove pattern having a predetermined shape and a predetermined size.

2. A flexible mold as defined in claim 1, wherein said support and said molding layer are transparent.

3. A flexible mold as defined in claim 1 or 2, wherein said support is a film of a hygroscopic plastic material.

4. A flexible mold as defined in claim 3, wherein said hygroscopic plastic material is at least one kind of plastic material selected from the group consisting of polyethylene terephthalate, polyethylene naphthalate, stretched polypropylene, polycarbonate and triacetate.

5. A flexible mold as defined in any one of claims 1 to 4, wherein said support has a thickness of 0.05 to 0.5 mm.

6. A flexible mold as defined in any one of claims 1 to 5, wherein said molding layer comprises a base layer made of a first curable material having a viscosity of 3,000 to 100,000 cps at 10 to 80°C and a coating layer made of a second curable material having a viscosity of not higher than 200 cps at 10 to 80°C, the coating layer being applied over a surface of said molding layer.

7. A flexible mold as defined in claim 6, wherein said first curable material and said second curable material are photo-curable materials.

8. A flexible mold as defined in any one of claims 1 to 7, wherein the groove pattern of said molding layer is a lattice pattern constituted by a plurality of groove portions arranged substantially in parallel while crossing one another with predetermined gaps among them.

9. A method of manufacturing a microstructure having a projection pattern having a predetermined shape and a predetermined size on a surface of a substrate, comprising the steps of:

preparing a flexible mold comprising a support made of a material having a tensile strength of at least 5 kg/mm^2 and containing moisture to saturation at a temperature and a relative humidity at the time of use by a humidity absorption treatment applied in advance, and a molding layer disposed on said support and having a groove pattern having a shape and a size corresponding to those of said projection pattern on a surface thereof;

arranging a curable molding material between said substrate and a molding layer of said mold and filling said molding material into said groove pattern of said mold;

curing said molding material and forming a microstructure having said substrate and said projection pattern integrally bonded to said substrate; and

releasing said microstructure from said mold.

10. A manufacturing method as defined in claim 9, wherein said molding material is a photo-curable material.

11. A manufacturing method as defined in claim 9 or 10, wherein said microstructure is a back plate for a plasma display panel.

12. A manufacturing method as defined in claim 11, which further comprises a step of independently arranging a set of address electrodes substantially in parallel with each other while keeping a predetermined gap between them on a surface of said substrate.

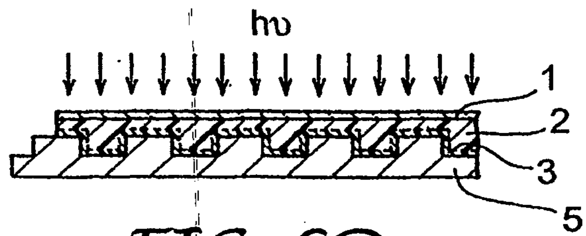

FIG. 6D

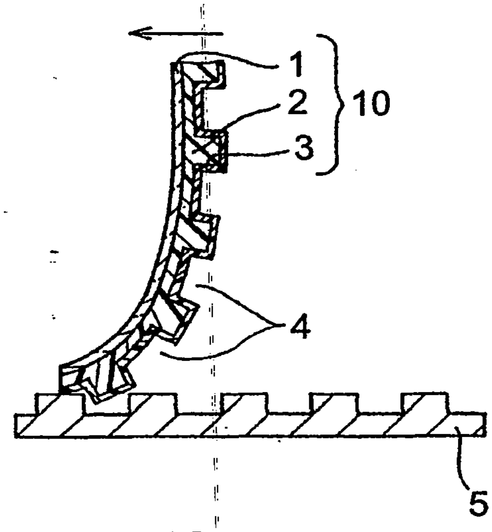

FIG. 6E

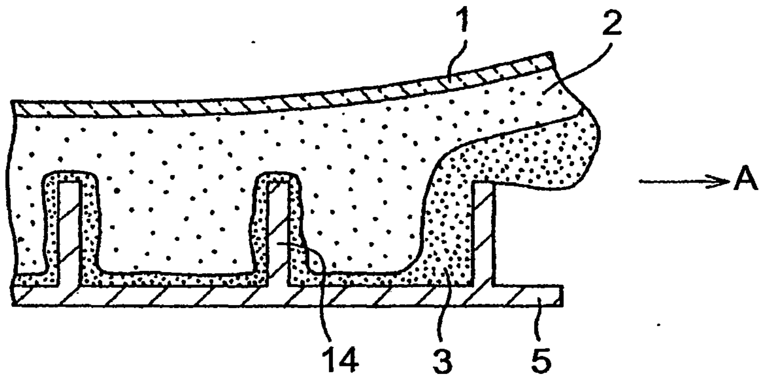

FIG. 7